CLAIMS

We claim:

1. An apparatus for condensing multi-component fluids comprising:
a plurality of heat exchange stages,
at least one scrubber, and
a plurality of mixers and splitters,
where the heat exchange stages and the at least one scrubber are interconnected in such a way that streams are split and mixed so that a mixed stream enters each heat exchange stage increasing a heat transfer coefficient in each of the heat exchange stages.

2. The apparatus of claim 1, where the plurality of heat exchange stages is two.

3. The apparatus of claim 1, where the plurality of heat exchange stages is three.

4. The apparatus of claim 1, where the plurality of heat exchange stages is four.

5. The apparatus of claim 1, where the plurality of heat exchange stages is more than four.

6. The apparatus of claim 1, further comprising a plurality of scrubbers, where the scrubber plurality is equal to or one less than the plurality of heat exchanger stages.

7. The apparatus of claim 6, where the heat exchange plurality is three and the scrubber plurality is two.

8. The apparatus of claim 1, wherein the exchange stages are heat exchangers.

9. An apparatus for condensing multi-component fluids comprising:
a first plurality of heat exchange stages,
a second plurality of scrubbers,
a third plurality of mixers, and
a fourth plurality of splitters,
where the heat exchange stages and the scrubbers are interconnected in such a way that

streams are split and mixed so that a mixed stream enters each heat exchange stage increasing a heat transfer coefficient in each of the heat exchange stages.

10. The apparatus of claim 1, where the plurality of heat exchange stages is two.

11. The apparatus of claim 1, where the plurality of heat exchange stages is three.

12. The apparatus of claim 1, where the plurality of heat exchange stages is four.

13. The apparatus of claim 1, where the plurality of heat exchange stages is more than four.

14. The apparatus of claim 1, further comprising a plurality of scrubbers, where the scrubber plurality is equal to or one less than the plurality of heat exchanger stages.

15. The apparatus of claim 6, where the heat exchange plurality is three and the scrubber plurality is two.

16. The apparatus of claim 1, wherein the exchange stages are heat exchangers.

17. A process for condensing multi-component fluids comprising the steps of:

feeding an input vapor stream comprising a multi-component fluid to a condensation system of claims 1-16;

splitting the input vapor stream into first and second vapor sub-streams;

forwarding the first vapor sub-stream to a lower port of a scrubber;

combining the second vapor sub-stream with a first scrubber liquid stream from a bottom port of the scrubber to form a first mixed stream;

passing the first mixed stream through a first heat exchanger where it is fully condensed forming a first condensed stream;

splitting the first condensed stream into first and second condensed sub-streams;

combining the second condensed sub-stream with a first scrubber vapor stream from an upper port of the first scrubber to form a second mixed stream;

forwarding the first condensed sub-stream to a top port of a scrubber;

counterflow compositionally equilibrating the first vapor sub-stream and the first condensed sub-stream in the scrubber, and

passing the second combined stream through a second heat exchanger where it is fully condensed forming a final liquid stream comprising a multi-component stream having a compositions the same or substantially the same as the input stream,

where the streams entering each heat exchanger are mixed streams having a composition designed to increase, optimize or maximize a heat transfer coefficient in each heat exchanger.

18. The process of claim 17, further comprising the steps of:

before the second splitting step, combining the first condensed stream with a second scrubber vapor stream from a port in a middle section of the scrubber to form a third mixed stream,

passing the third mixed stream through a third heat exchanger where it is fully condensed forming a second condensed stream.

19. The process of claim 17, further comprising the steps of:

before the second splitting step, splitting the first condensed stream into third and forth condensed sub-streams,

forwarding the forth condensed sub-stream to a port in a middle section of the scrubber;

combining the third condensed sub-stream with a second scrubber vapor stream from a port in the middle section of the scrubber to form a third mixed stream,

passing the third mixed stream through a third heat exchanger where it is fully condensed forming a second condensed stream.

20. The process of claim 17, further comprising the steps of:

before the second splitting step, combining the first condensed stream into second scrubber liquid stream from a port in a middle section of the scrubber to form a third combined stream,

combining the third combined stream with a second scrubber vapor stream from another port in the middle section of the scrubber to form a third mixed stream,

passing the third mixed stream through a third heat exchanger where it is fully condensed forming a second condensed stream.

21. A process for condensing multi-component fluids comprising the steps of:

feeding an input vapor stream comprising a multi-component fluid to a condensation system of claims 1-16;

splitting the input vapor stream into first and second vapor sub-streams;

forwarding the first vapor sub-stream to a lower port of a first scrubber;

combining the second vapor sub-stream with a first scrubber liquid stream from a bottom port of a second scrubber to form a first mixed stream;

passing the first mixed stream through a first heat exchanger where it is fully condensed forming a first condensed stream;

combining the first condensed stream with a first scrubber vapor stream from a port in a middle section of the first scrubber to form a second mixed stream,

passing the second mixed stream through a second heat exchanger where it is fully condensed forming a second condensed stream

splitting the second condensed stream into first and second condensed sub-streams;

combining the second condensed sub-stream with a second scrubber vapor stream from an upper port of the second scrubber to form a third mixed stream;

forwarding the first condensed sub-stream to a top port of the first scrubber;

forwarding a second scrubber liquid stream from a bottom port of the first scrubber to a top port of the second scrubber,

forwarding a third scrubber vapor stream from an upper port of the first scrubber to a lower port of the second scrubber,

counterflow compositionally equilibrating the first vapor sub-stream and the first condensed sub-stream in the first scrubber,

counterflow compositionally equilibrating the second scrubber liquid stream and the third scrubber vapor stream in the second scrubber, and

passing the third mixed stream through a third heat exchanger where it is fully condensed forming a final liquid stream comprising a multi-component stream having a compositions the same or substantially the same as the input stream,

where the streams entering each heat exchanger are mixed streams having a composition designed to increase, optimize or maximize a heat transfer coefficient in each heat exchanger.

22. The process of claim 21, further comprising the steps of:

before the second splitting step, combining the first condensed stream with a second scrubber vapor stream from a port in a middle section of the scrubber to form a third mixed stream,

passing the third mixed stream through a third heat exchanger where it is fully condensed forming a second condensed stream.

23. The process of claim 21, further comprising the steps of:

before the second splitting step, splitting the first condensed stream into third and forth condensed sub-streams,

forwarding the forth condensed sub-stream to a port in a middle section of the scrubber;

combining the third condensed sub-stream with a second scrubber vapor stream from a port in the middle section of the scrubber to form a third mixed stream,

passing the third mixed stream through a third heat exchanger where it is fully condensed forming a second condensed stream.

24. The process of claim 21, further comprising the steps of:

before the second splitting step, combining the first condensed stream into second scrubber liquid stream from a port in a middle section of the scrubber to form a third combined stream,

combining the third combined stream with a second scrubber vapor stream from another port in the middle section of the scrubber to form a third mixed stream,

passing the third mixed stream through a third heat exchanger where it is fully condensed forming a second condensed stream.